

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE
FOR

FMVSS 218

Motorcycle Helmets



SAFETY ASSURANCE
Office of Vehicle Safety Compliance
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Washington, DC 20590

OVSC LABORATORY TEST PROCEDURE NO. 218
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REVISION CONTROL LOG FOR OVSC LABORATORY TEST PROCEDURES

TP-218
(Motorcycle Helmets)

TEST PROCEDURE		FMVSS 000		DESCRIPTION
REV. No.	DATE	AMENDMENT	EFFECTIVE DATE	
00	xx/xx/xx	xxFRxxxx	xx/xx/xx	Original release signed by O.D.
01				
02				
03				
04	6/27/2003	original		Updated (new codes, metric equivalents, correct typos), add retention test pull rate, impact test locations and miscellaneous changes.
05				
06				
07				
08				
09				
10				

1. PURPOSE AND APPLICATION

The Office of Vehicle Safety Compliance (OVSC) provides contracted laboratories with Laboratory Test Procedures (TPs) which serve as guidelines for obtaining compliance test data. The data are used to determine if a specific vehicle or item of motor vehicle equipment meets the minimum performance requirements of the subject Federal Motor Vehicle Safety Standard (FMVSS). The purpose of the OVSC Laboratory Test Procedures is to present a uniform testing and data recording format, and provide suggestions for the use of specific equipment and procedures. Any contractor interpreting any part of an OVSC Laboratory Test Procedure to be in conflict with a Federal Motor Vehicle Safety Standard or observing any deficiencies in a Laboratory Test Procedure is required to advise the Contracting Officer's Technical Representative (COTR) and resolve the discrepancy prior to the start of compliance testing.

Contractors are required to submit a detailed test procedure to the COTR before initiating the compliance test program. The procedure must include a step-by-step description of the methodology to be used.

The OVSC Laboratory Test Procedures are not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment that will assist in procuring the required compliance test data.

NOTE:

The OVSC Laboratory Test Procedures, prepared for use by independent laboratories under contract to conduct compliance tests for the OVSC, are not intended to limit the requirements of the applicable FMVSS(s). In some cases, the OVSC Laboratory Test Procedures do not include all of the various FMVSS minimum performance requirements. Sometimes, recognizing applicable test tolerances, the Test Procedures specify test conditions that are less severe than the minimum requirements of the standards themselves. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits certification tests to those described in the OVSC Laboratory Test Procedures.

2. GENERAL REQUIREMENTS

FMVSS 218 establishes minimum performance requirements for helmets designed for use by motorcyclists and other motor vehicle users. The purpose of Standard 218 is to reduce deaths and injuries to motorcyclists and other motor vehicle users resulting from head impacts. Standard 218 applies to all helmets designed for use by motorcyclists and other motor vehicle users. Each helmet shall meet the requirements of the following when subjected to any conditioning procedure specified in S6.4 and tested in accordance with S7.1, S7.2, and S7.3.

Metric units are used throughout this document with English equivalents in parentheses presented for information only: kilograms (pounds) for force, centimeters (inches) for displacement, and meters per second squared (feet per second per squared) for velocity. All data shall be presented in metric units.

A. **IMPACT ATTENUATION** — When an impact attenuation test is conducted in accordance with S7.1, all of the following requirements shall be met:

- (1) Peak accelerations shall not exceed 400g
- (2) Accelerations in excess of 200g shall not exceed a cumulative duration of 2.0 milliseconds (msec)
- (3) Accelerations in excess of 150g shall not exceed a cumulative duration of 4.0 milliseconds (msec)

B. **PENETRATION** — When a penetration test is conducted in accordance with S7.2, the striker shall not contact the surface of the test headform.

C. **RETENTION SYSTEM** — When tested in accordance with S7.3:

- (1) The retention system or its components shall withstand the loads specified without separation.
- (2) The adjustable portion of the retention system test device shall not move more than 2.5 cm (1 inch) measured between preliminary and test load positions.

Where the retention systems consist of components that can be independently fastened without securing the complete assembly, each such component shall independently meet the requirements listed above.

D. **CONFIGURATION** — Each helmet shall have a protective surface of continuous contour at all points on or above the test line described in S6.2.3. The helmet shall provide peripheral vision clearance of at least 105 degrees to each side of the mid-sagittal plane, when the helmet is adjusted as specified in S6.3. The vertex of these angles, shown on Figure 1, shall be at the point on the anterior surface of the reference headform at the intersection of the midsagittal and basic planes. The brow opening of the helmet shall be at least 2.5 cm (1 inch) above all points in the basic plane that are within the angles of peripheral vision as shown in Figure 1.

2. GENERAL REQUIREMENTS....Continued

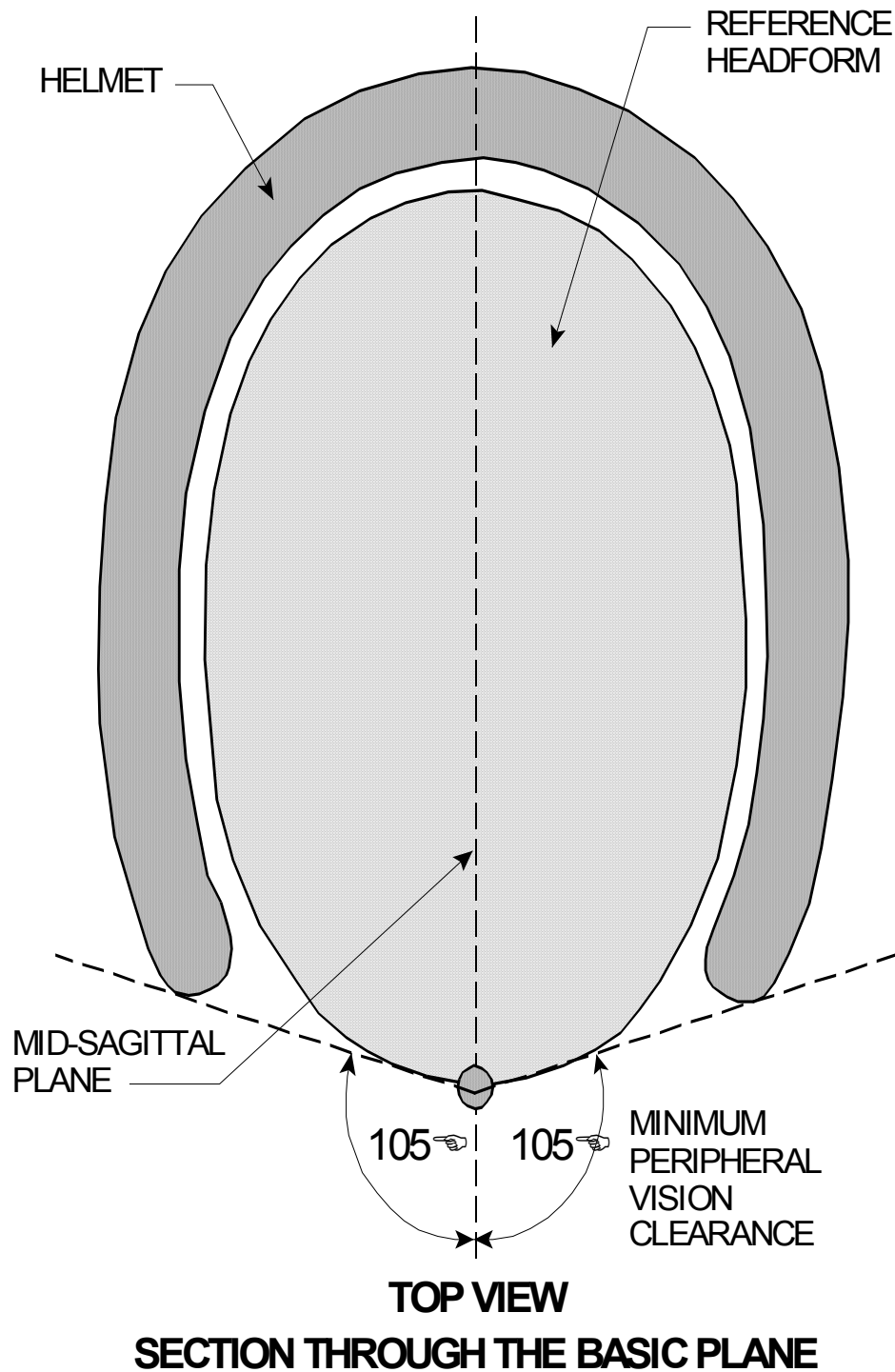
PERIPHERAL VISION

FIGURE 1

2. GENERAL REQUIREMENTS....Continued

- E. **PROJECTIONS** — A helmet shall not have any rigid projections inside and any projection outside any helmet's shell shall be limited to those required for operation of essential accessories, and shall not protrude more than 5 mm (0.20 inch).
- F. **LABELING** — Each helmet shall be labeled permanently and legibly, in a manner such that the label(s) can be read easily without removing padding or any other permanent part. Label permanency means that the label **cannot be removed intact**, i.e., removal can only be accomplished by destruction or removal of the label in pieces. This applies to the following labels:
- (1) Manufacturer's name or identification
 - (2) Precise model designation
 - (3) Size
 - (4) Month and year of manufacture. This may be spelled out (for example, June 1990), or expressed in numerals (for example, 6/90). Note: There is no prohibition against date codes being used. They may be used if they may be easily identified as the date of manufacture, they contain the required information and they are easily decipherable.
 - (5) The symbol DOT, constituting the manufacturer's certification that the helmet conforms to the applicable Federal Motor Vehicle Safety Standards. This symbol shall appear on the outer surface, in a color that contrasts with the background, in letters at least 1 cm (0.375 inch) high, centered laterally with the horizontal centerline of the symbol located a minimum of 2.9 cm (1.125 inches) and a maximum of 3.5 cm (1.375 inches) from the bottom edge of the posterior portion of the helmet.
 - (6) Instructions to the purchaser as follows:
 - (A) "Shell and liner constructed of (**identify type(s) of materials**)"
 - (B) "Helmet can be seriously damaged by some common substances without damage being visible to the user. Apply only the following: (Recommended cleaning agents, paints, adhesives, etc., as appropriate)"
 - (C) "Make no modifications. Fasten helmet securely. If helmet experiences a severe blow, return it to the manufacturer for inspection, or destroy it and replace it."
 - (D) Any additional relevant safety information should be supplied at the time of purchase by means of an attached tag, brochure, or other suitable means

2. GENERAL REQUIREMENTS....Continued

- G. **HELMET POSITIONING INDEX** — Each manufacturer of helmets shall establish a positioning index for each helmet he or she manufactures. This index shall be furnished immediately to any person who requests the information, with respect to a helmet identified by manufacturer, model designation, and size.

3. SECURITY

The contractor shall provide appropriate security measures to protect the OVSC test equipment from unauthorized personnel during the entire compliance testing program. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of test equipment. Any security problems which arise shall be reported by telephone to the Industrial Property Manager (IPM), Office of Contracts and Procurement, within two working days after the incident. A letter containing specific details of the security problem will be sent to the IPM (with copy to the COTR) within 48 hours. The contractor shall protect and segregate the data that evolves from compliance testing before and after each test. No information concerning the safety compliance testing program shall be released to anyone except the COTR, unless specifically authorized by the COTR or the COTR's Division Chief or Department Head.

NO INDIVIDUALS, OTHER THAN CONTRACTOR PERSONNEL DIRECTLY INVOLVED IN THE COMPLIANCE TESTING PROGRAM, SHALL BE ALLOWED TO WITNESS ANY MOTORCYCLE HELMET COMPLIANCE TEST UNLESS SPECIFICALLY AUTHORIZED BY THE COTR.

4. GOOD HOUSEKEEPING

Contractors shall maintain the entire equipment compliance testing area, test fixtures and instrumentation in a neat, clean and painted condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

5. TEST SCHEDULING AND MONITORING

The contractor shall submit a test schedule to the COTR prior to testing. Tests shall be completed as required in the contract. All testing shall be coordinated to allow monitoring by the COTR.

6. TEST DATA DISPOSITION

The contractor shall make all preliminary compliance test data available to the COTR on location within four hours after the test. Final test data, including digital printouts and computer generated plots (if applicable), shall be furnished to the COTR within five working days. Additionally, the contractor shall analyze the preliminary test results as directed by the COTR.

All backup data sheets, strip charts, recordings, plots, technicians notes, etc., shall be either sent to the COTR or retained by the contractor for a minimum of three years.

7. GOVERNMENT FURNISHED PROPERTY (GFP)

ACCEPTANCE OF TEST EQUIPMENT

All helmets of an individual test sample shall be inspected within one week of receipt at the laboratory. Any damaged helmet is unacceptable for testing. Date of receipt and condition of all helmets shall be recorded.

After inspection, helmets shall be assigned laboratory identification codes and then stored in a clean, dry, secure storage area to prevent damage to them in any manner that may affect test results.

NOTIFICATION OF COTR

The COTR must be notified within 24 hours after the compliance test equipment has been delivered.

8. CALIBRATION OF TEST INSTRUMENTS

Before the contractor initiates the safety compliance test program, a test instrumentation calibration system will be implemented and maintained in accordance with established calibration practices. Guidelines for setting up and maintaining such calibration systems are described in ANSI/NCSL Z540-1-1994, Calibration Laboratories and Measuring and Test Equipment – General Requirements. The calibration system shall be set up and maintained as follows:

- A. Standards for calibrating the measuring and test equipment will be stored and used under appropriate environmental conditions to assure their accuracy and stability.
- B. **All measuring instruments and standards shall be calibrated by the contractor, or a commercial facility, against a higher order standard at periodic intervals NOT TO EXCEED TWELVE (12) MONTHS!** Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.
- C. All measuring and test equipment and measuring standards will be labeled with the following information:
 - (1) Date of calibration
 - (2) Date of next scheduled calibration
 - (3) Name of the technician who calibrated the equipment
- D. A written calibration procedure shall be provided by the contractor which includes as a minimum the following information for all measurement and test equipment:
 - (1) Type of equipment, manufacturer, model number, etc.
 - (2) Measurement range

8. CALIBRATION OF TEST INSTRUMENTS (continued)

- (3) Accuracy
 - (4) Calibration interval
 - (5) Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)
- E. Records of calibration for all test instrumentation shall be kept by the contractor in a manner which assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COTR. The calibration system will need the acceptance of the COTR before the test program commences.

9. PHOTOGRAPHIC DOCUMENTATION

Each final test report shall include clear and legible 4" x 5" color images, any format with minimum resolution of 150 dpi. It is suggested that the following format be used for these photographs:

A representative helmet shall be positioned so as to provide a complete visual description of the helmet.

- A. 3/4 frontal view
- B. Interior view, with retention system hardware clearly shown, including labels
- C. Rear or other view that clearly shows the required permanent marking
- D. A view of the helmet showing both penetration sites
- E. A one page, legible collage of all labels not legibly shown in the other views
- F. Representative views of failures as described below:

Any visually apparent damage, associated with a failure or the inability of a helmet to complete the test program, shall be photographed and the photographs included in the final test report.

Any witness marks that clearly show evidence of a failure, especially where damage associated with a failure may be difficult or impossible to see. (See Penetration Tests)

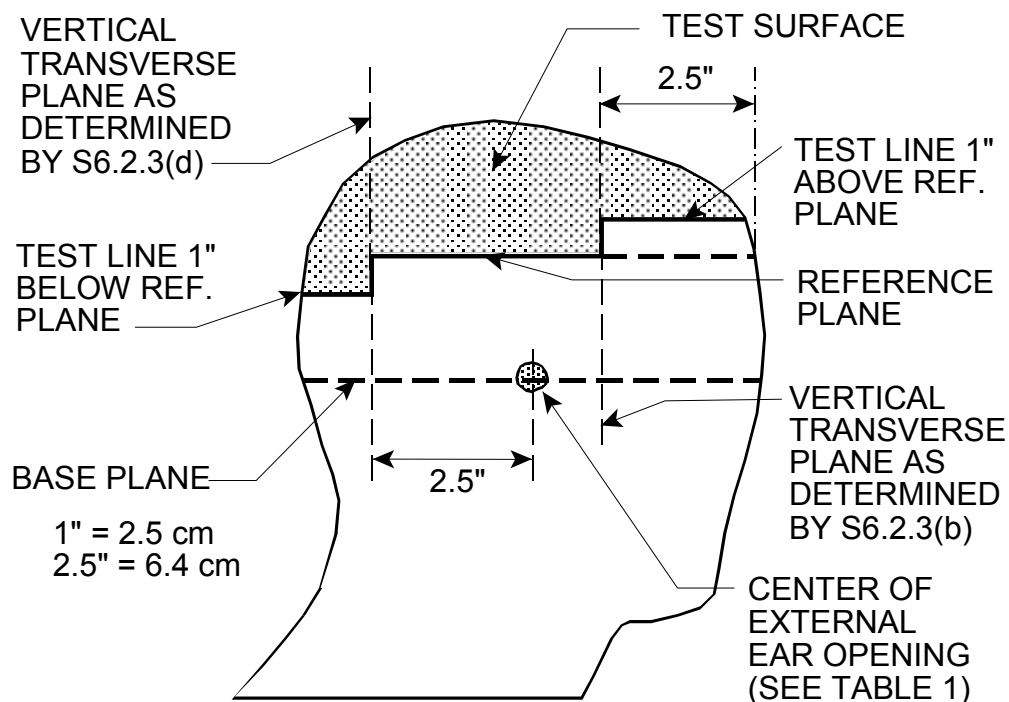
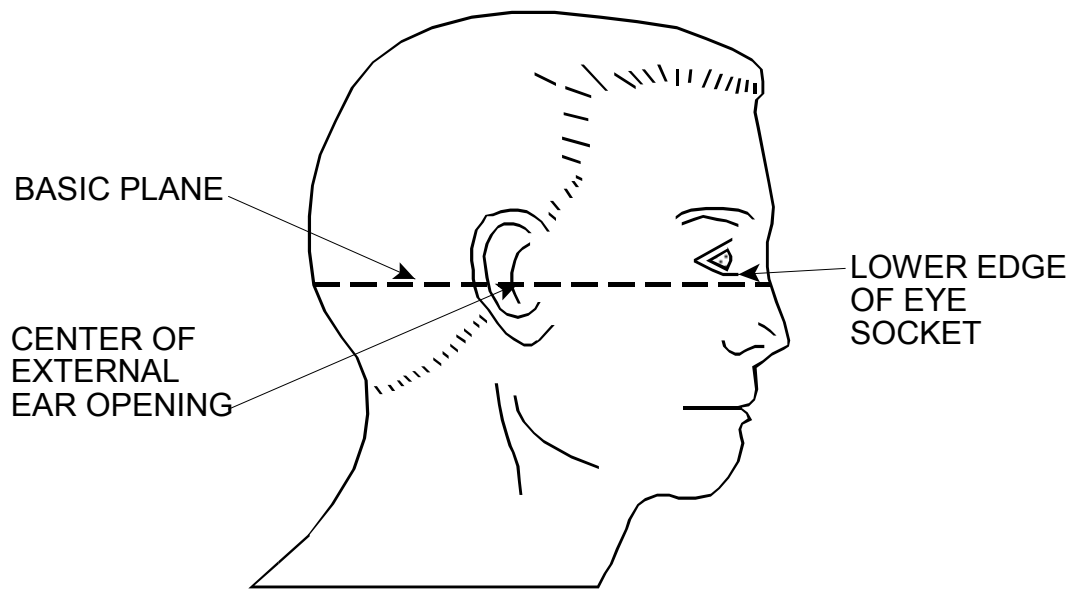
A photograph or digital image of the test setup for each phase of testing shall be required in each final test report. The photographs or digital images may be used to reproduce the original photographs, provided the images are clear and may be reproduced with clarity on standard office copying equipment.

10. DEFINITIONS

BASIC PLANE

A plane through the centers to the right and left external ear openings and the lower edge of the eye sockets as shown below of a reference headform or test headform also shown in Figure 2.

BASIC PLANE and TEST LINE



NOTE: Solid lines would correspond to the test line on a test helmet.

FIGURE 2

10. DEFINITIONS....Continued

HELMET POSITIONING INDEX

The distance in inches, as specified by the manufacturer, from the lowest point of the brow opening at the lateral midpoint of the helmet to the basic plane of a reference headform, when the helmet is firmly and properly positioned on the reference headform.

MIDSAGITTAL PLANE

A longitudinal plane through the apex of a reference headform or test headform that is perpendicular to the basic plane as shown below in Figure 1.

PERIPHERAL VISION

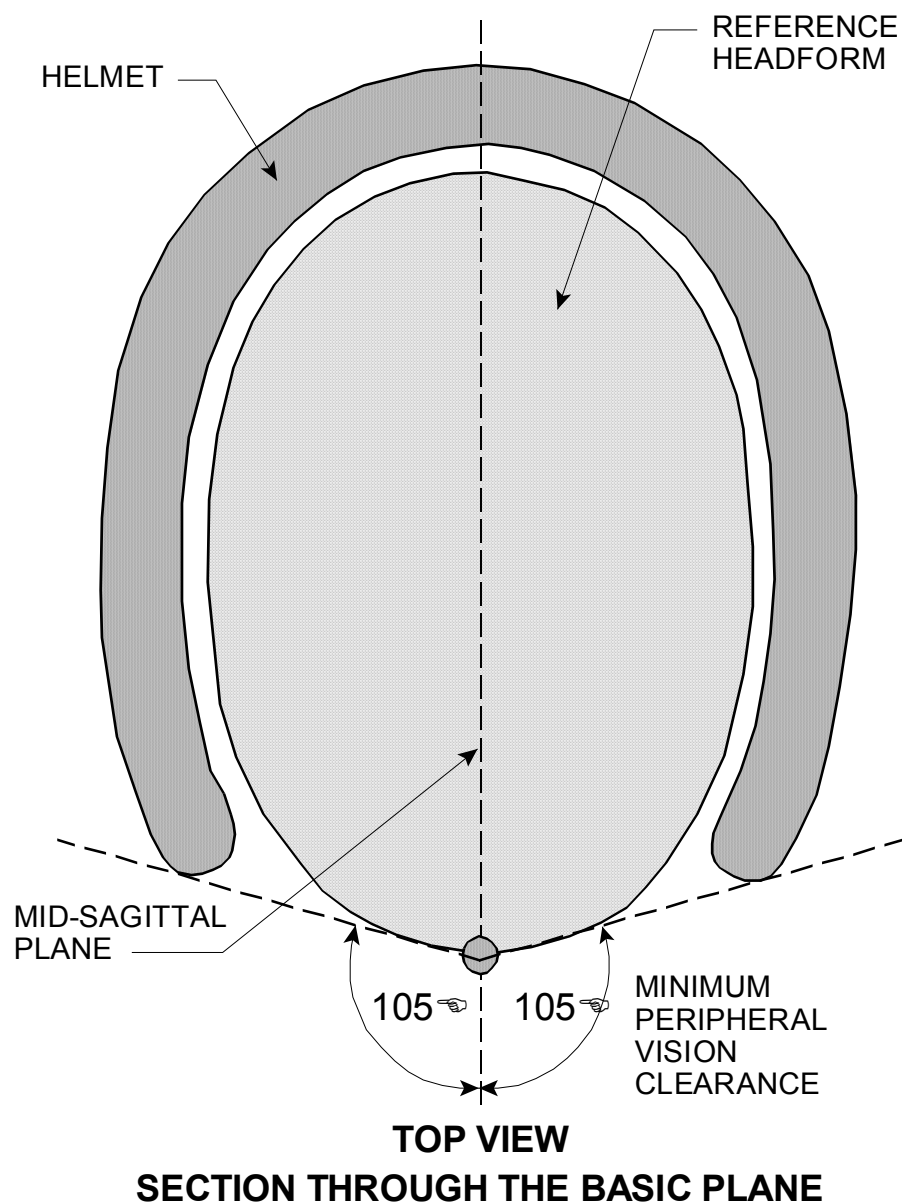


FIGURE 1

10. DEFINITIONS....Continued

REFERENCE HEADFORM

A measuring device contoured to the dimensions of one of the three headforms described in Table 1, with surface markings indicating the locations of the basic, midsagittal, and reference planes, and the centers of the external ear openings.

REFERENCE PLANE

A plane above and parallel to the basic plane on a reference headform or test headform (Figure 2) at the distance indicated in Table 1.

RETENTION SYSTEM

The complete assembly by which the helmet is retained in position on the head during use.

TEST HEADFORM

A test device contoured to the dimensions of one of the three headforms described in Table 1, with surface markings indicating the locations of the basic, mid-sagittal, and reference planes.

11. PRETEST REQUIREMENTS

Prior to conducting any compliance test, contractors are required to submit a detailed in-house compliance test procedure to the COTR which includes a step-by-step description of the methodology to be used. Written approval must be obtained from the COTR before initiating the compliance test program so that all parties are in agreement.

TEST DATA LOSS

A compliance test is not to be conducted unless all of the various test conditions specified in the applicable OVSC Laboratory Test Procedure have been met. Failure of a contractor to obtain the required test data and to maintain acceptable limits on test parameters in the manner outlined in the applicable OVSC Laboratory Test Procedure may require a retest at the expense of the contractor. The retest costs will include the cost of the replacement item of motor vehicle equipment and all costs associated with conducting the retest. The original test specimen used for the invalid test shall remain the property of OVSC, and the retest specimen shall remain the property of the contractor. If there is a test failure, the contractor shall retain the retest specimen for a period not exceeding 180 days. If there is no test failure, the Contractor may dispose of the test specimen upon notification from the COTR that the final test report has been accepted.

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the contractor that a retest is required. The retest shall be completed within two (2) weeks after receipt of notification by the Contracting Officer that a retest is required. If a retest is conducted, no test report is required for the original test.

RECORDING OF DATA

Environment

Environmental data (test area and conditioning environments) shall be continuously and permanently recorded on strip charts, circular charts or other suitable print-out media throughout the testing period.

Test Data

The performing agency shall, with appropriate instrumentation, permanently record the following test parameters:

- A. Headform accelerations from impact test (FMVSS 218, S7.1) shall read within $\pm 5\%$ and corresponding dwell times in milliseconds (msec) shall read within $\pm 2\%$ of actual values.
- B. Outcome of penetration test (indication of contact, if any — FMVSS 218, S7.2).

11. PRETEST REQUIREMENTS....Continued

- C. Retention system test loads (FMVSS 218, S7.3).
- D. Net displacement of the adjustable portion of retention system test device (FMVSS 218, S7.3.4). Displacement shall be measurable to an accuracy of $\pm 0.0254\text{cm}$ (0.010 inch).

12. COMPLIANCE TEST EXECUTION

TEST EQUIPMENT

Test equipment items are listed below. The required range and accuracy of the equipment are included, where applicable.

GENERAL TEST CONDITIONS

Unless otherwise specified, all tests and measurements shall be conducted under the following environmental conditions:

Room Ambient	21°C ± 6°C (70°F ± 10°F)
Relative Humidity	40% to 60%

The laboratory shall be capable of setting, controlling, and reading the environmental condition parameters so that when the accuracies of the instrumentation and the systems are considered in evaluating the recorded data the results are within the upper and lower limits of the specifications. Continuous recording of environmental conditions shall be provided for during all phases of testing.

TEST QUANTITIES

Five (5) structurally identical helmets of the same size and similar dates of manufacture shall be provided for a test program, four of which shall be subjected to the prescribed series of tests after proper environmental conditioning.

TEST PERSONNEL PERFORMANCE

Technicians charged with the responsibility of performing the compliance test program shall be thoroughly familiar with the requirements and test conditions for each test phase to be performed. Each technician shall be specifically instructed in the proper operation of all equipment employed in conducting these tests. Personnel supervising the compliance test program shall be thoroughly familiar with the requirements, test conditions, and equipment for the test to be conducted.

TEST SEQUENCE

The various tests shall be performed in the following sequence:

- A. Visual and dimensional inspection (peripheral vision, etc.)

FMVSS 218, S5.4, S5.3, S5.6, S5.7
- CONDITIONING -

12. COMPLIANCE TEST EXECUTION....Continued

- B. Impact attenuation — FMVSS 218, S7.1
- C. Penetration resistance — FMVSS 218, S7.2
- D. Retention System strength — FMVSS 218, S7.3

TEST REQUIREMENTS AND PROCEDURES

For the purpose of compliance testing, the following interpretations and clarifications of FMVSS 218 are presented below.

PREPARATION OF TEST SAMPLES

A. Marking

Each helmet shall be marked, prior to testing, in accordance with the procedure detailed in S6.2 of FMVSS 218, including horizontal and vertical lines. It is suggested that a marking fixture be designed and constructed for this purpose. This fixture may serve the two-fold purpose of —

- (1) Applying the $4.5 \pm 0.05\text{kg}$ (10 pound ± 0.1 pounds) "seating load" to the apex of the helmet (this may be accomplished with dead weight)
- (2) Providing positioning indicators (on a base plate or otherwise external to the reference headform) to assure consistent accurate marking.

The impact sites, once chosen, shall be marked on the helmet shell to insure that the two successive blows are delivered to the same location (should the helmet shift due to impact and require repositioning).

In addition to the above described marking, each helmet shall be labeled with a laboratory assigned serial number and the environmental condition to which it will be subjected, prior to, and during testing.

CAUTION: Certain substances which could be used to mark helmets may cause chemical degradation of the shell material. It is therefore suggested that only water base markers or wax pencils be used for this purpose.

B. Peripheral Vision

Peripheral vision shall be measured while the helmet is properly positioned and seated, with a 4.5kg (10 pound) static load, on the reference head-form. A device with an accuracy of $\pm 1^\circ$ shall be used for this measurement.

12. COMPLIANCE TEST EXECUTION....Continued

Each helmet shall provide a minimum peripheral vision of 105 degrees to each side of midsagittal plane.

C. Environmental Conditioning

Prior to testing, one (1) each of the sample helmets shall be maintained at the following environmental conditions for a minimum period of 12 hours —

Room Ambient	$21^{\circ}\text{C} \pm 6^{\circ}$	($70^{\circ}\text{F} \pm 10^{\circ}\text{F}$)
High Temperature	$50^{\circ}\text{C} + 0^{\circ}\text{C}, - 4^{\circ}\text{C}$	($122^{\circ}\text{F}, + 0^{\circ}\text{F}, - 8^{\circ}\text{F}$)
Low Temperature	$- 10^{\circ}\text{C} + 4^{\circ}\text{C}, - 0^{\circ}\text{C}$	($14^{\circ}\text{F}, + 8^{\circ}\text{F}, - 0^{\circ}\text{F}$)
Water Immersion	$25^{\circ}\text{C} \pm 6^{\circ}\text{C}$	($77^{\circ}\text{F} \pm 10^{\circ}\text{F}$)

Testing shall commence immediately upon removal of the helmet from its conditioning environment. Should the time out of conditioning environment exceed 4 minutes, the helmet must be returned to the conditioning environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or 12 hours, whichever is less, prior to resumption of testing.

The laboratory shall be capable of setting, controlling, and reading the environmental conditioning equipment so that when the accuracies of the instrumentation and the systems are considered in evaluating the recorded data the results are within the upper and lower limits of the specifications.

IMPACT ATTENUATION

The following detail clarifications shall apply to the items and requirements specified in FMVSS 218, S7.1.

A. Test Setup and Equipment Tolerances

A monorail drop test system is used for impact attenuation.

The apparatus used to guide the drop assembly shall be so constructed as to assure a free fall within $\pm 1^{\circ}$ of vertical.

The guide-drop assembly interface shall be designed with suitable tolerances and materials in order to minimize any frictional effects.

To insure that the mechanical drop system is functioning properly, the performing agency shall periodically determine the actual impact velocity of the drop assembly from the two test drop heights. The actual velocity shall

12. COMPLIANCE TEST EXECUTION....Continued

be taken as the average of 3 drops from each test drop height. These velocities shall be within + 0%, - 5% of the theoretical velocity.

NOMINAL DROP HEIGHT	THEORETICAL IMPACT VELOCITY	MINIMUM ACCEPTABLE VELOCITY
138.4cm (54.5 in)	5.2m/sec (17.1 ft/sec)	4.94m/sec (16.23 ft/sec)
182.9cm (72.0 in)	6.0m/sec(19.7 ft/sec)	5.70m/sec (18.72 ft/sec)

The laboratory must be capable of setting the drop heights so that when the accuracy of the measuring device is considered in evaluating the recorded data the velocity results are within the specified limits.

Drop Assembly Weights

The combined weight of the instrumented test headform and supporting assembly for impact tests shall be as follows:

SMALL	3.5kg, + 0.00kg, -0.063kg (7.8 lbs, + 0.00 lbs, - 0.14 lbs)
MEDIUM	5.0kg, + 0.00kg, - 0.090kg (11.0 lbs, + 0.00 lbs, - 0.20 lbs)
LARGE	6.1kg, + 0.00kg, -0.108 kg (13.4 lbs, + 0.00 lbs, - 0.24 lbs)

B. Preparation of Test Equipment

Prior to the start of testing, all equipment is to be turned on and allowed to warm up for a minimum of 30 minutes or until equilibrium is reached, whichever is longer.

C. Impact Test — Systems Check

Immediately prior to, and at the conclusion of impact testing, the entire system shall be tested for possible faults by making a series of check drops onto a standardized impact media (a 1-inch open blue Modular Elastomer Programmer (MEP) Calibration Pad has proven suitable for this purpose).

The drop height and media for these checks shall be chosen to demonstrate the system's capability to produce and record an acceleration vs time history of (nominally) 400g's with a minimum 1 msec duration above 200g's. (For example, the drop height should be in the range of 127cm \pm 12.7cm (50 inches \pm 5 inches) if the above referenced MEP, or equivalent impact media, is used.)

A systems check will consist of 6 drops made at 2-minute intervals. The first 3 drops are considered "warm-up" drops. Permanent recording of data is not required for these impacts. The second 3 drops are for record

12. COMPLIANCE TEST EXECUTION....Continued

purposes and the results of these drops shall become part of the test data presented in the final report.

A system shall be considered defective if —

- (1) accelerations in excess of 375g's cannot be attained
- (2) the average of pretest and post test checks (record drops only) differ by more than 40g's.

If, at the completion of the impact portion of a test program, the second condition is found to exist, the entire impact series shall be considered invalid.

NOTES: (1) Check drops will be made using the bare headform and drop assembly employed in conducting the impact attenuation test. (2) The headform shall be aligned such that the point of impact is 1.27cm (1/2 inch) above the reference line (at the front of the headform) along the midsagittal plane. Ensure that the point of impact and accelerometer axis are vertically aligned.

D. Impact Test Procedure

- (1) Once systems checks are completed, replace the MEP with either of the two steel anvils. Align the center of gravity of the test headform for the desired impact location. The center of gravity is located in the center of the mounting ball on the supporting assembly and lies within a cone with its axis vertical and forming a 10° included angle with the vertex at the point of impact. The center of gravity of the drop assembly lies within the rectangular volume bounded by $x = -0.64$ cm (-0.25 inch), $x = 2.16$ cm (0.85 inch), $y = 0.64$ cm (0.25 inch) and $y = -0.64$ cm (-0.25 inch) with the origin located at the center of gravity of the test headform. The rectangular volume has no boundary along the z-axis. The x-y-z axes are mutually perpendicular and have positive or negative designations in accordance with the right-hand rule (See Figure 3). The origin of the coordinate axes also is located at the center of the mounting ball on the supporting assembly (See Figure 4, 5, and 6).

The x-y-z axes of the test headform assembly on a monorail drop test equipment are oriented as follows:

From the origin, the x-axis is horizontal with its positive direction going along toward and passing through the vertical

12. COMPLIANCE TEST EXECUTION....Continued

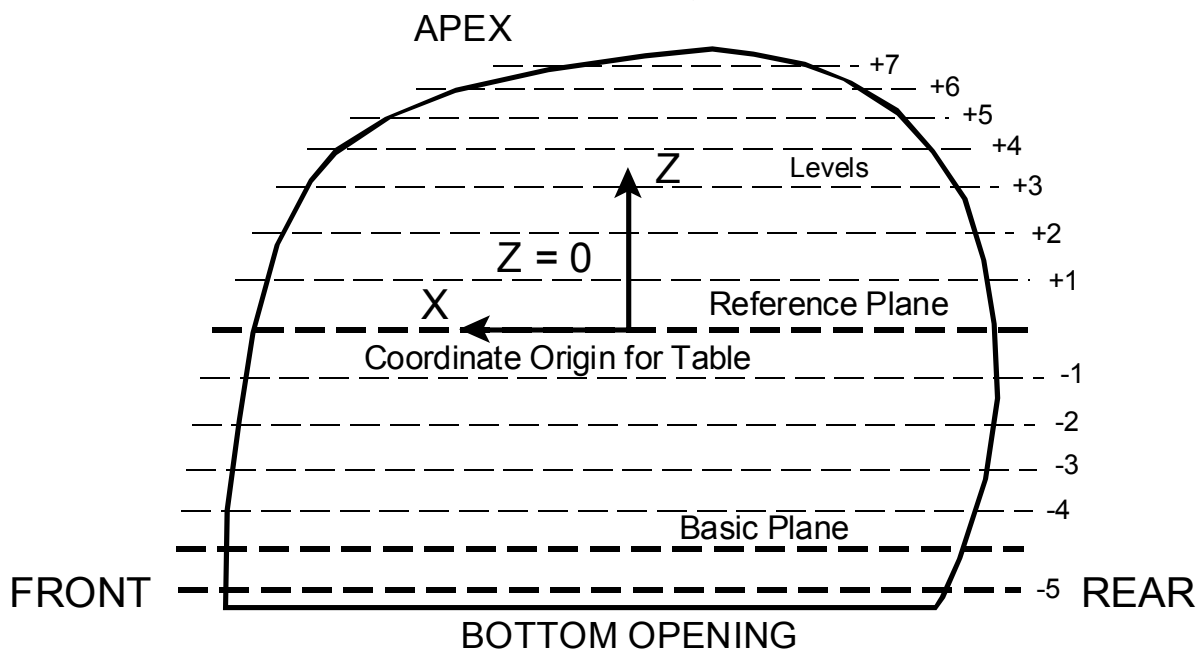
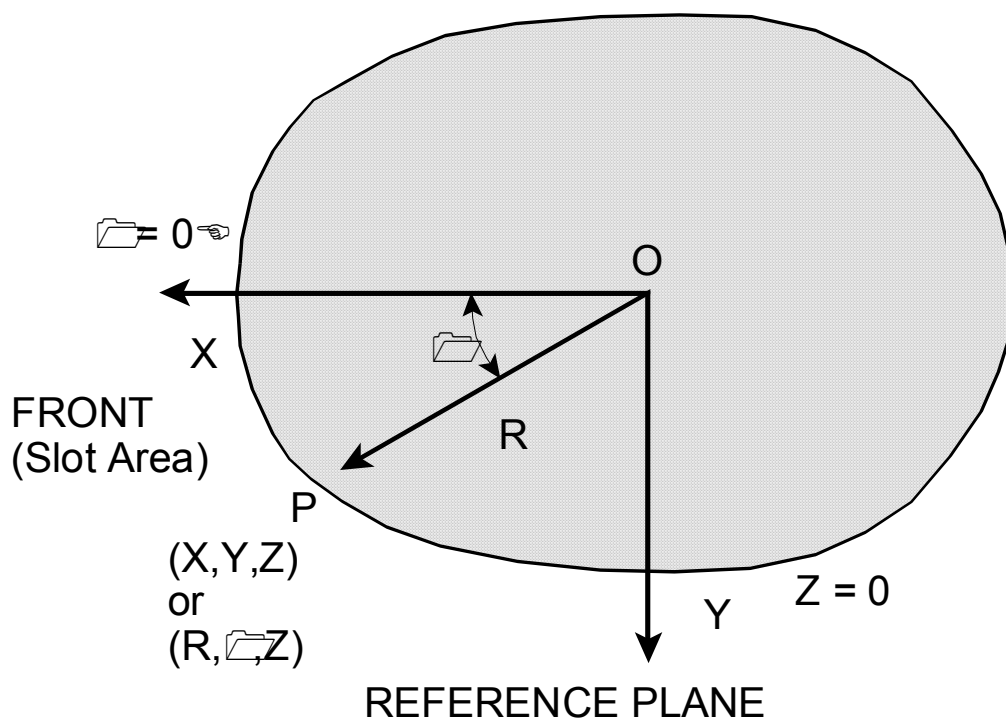
HEADFORM SECTIONS**MID-SAGITTAL PLANE (Symmetrical Plane)****HEADFORM COORDINATE SYSTEMS (Right Hand Rule)**

FIGURE 3

12. COMPLIANCE TEST EXECUTION....Continued

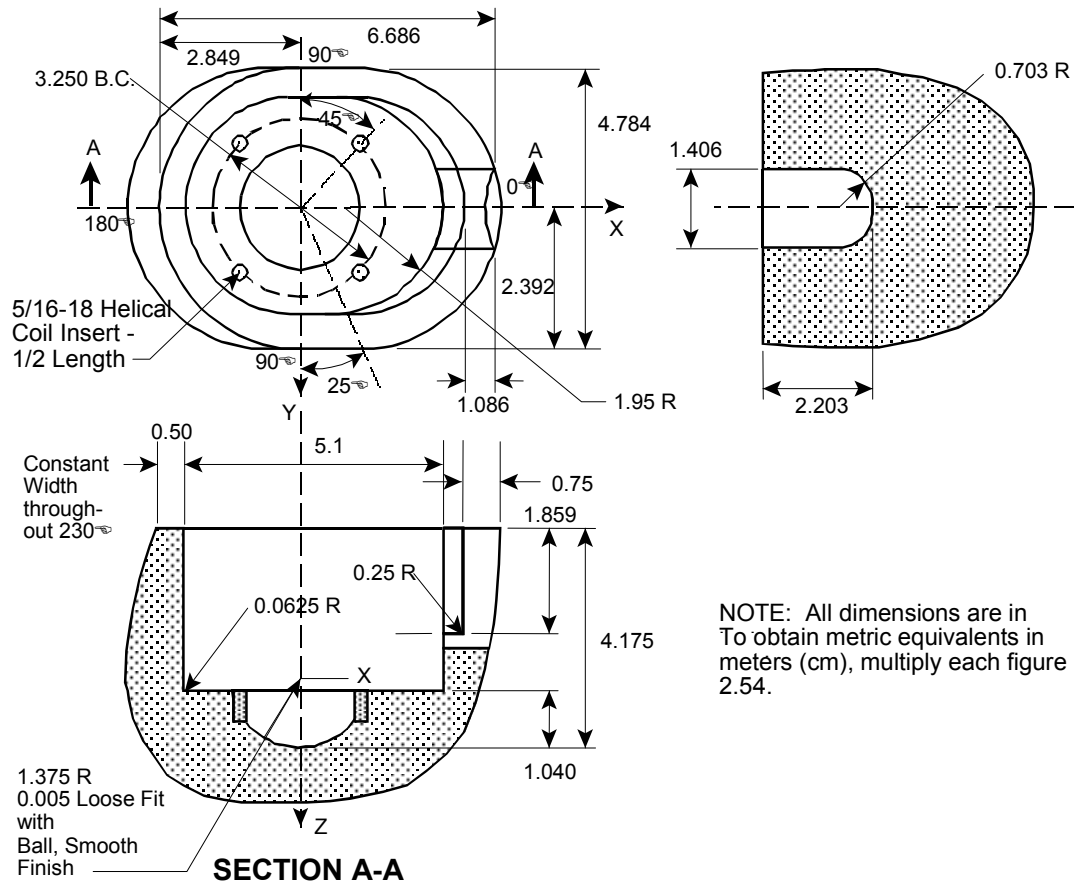
SMALL HEADFORM

FIGURE 4

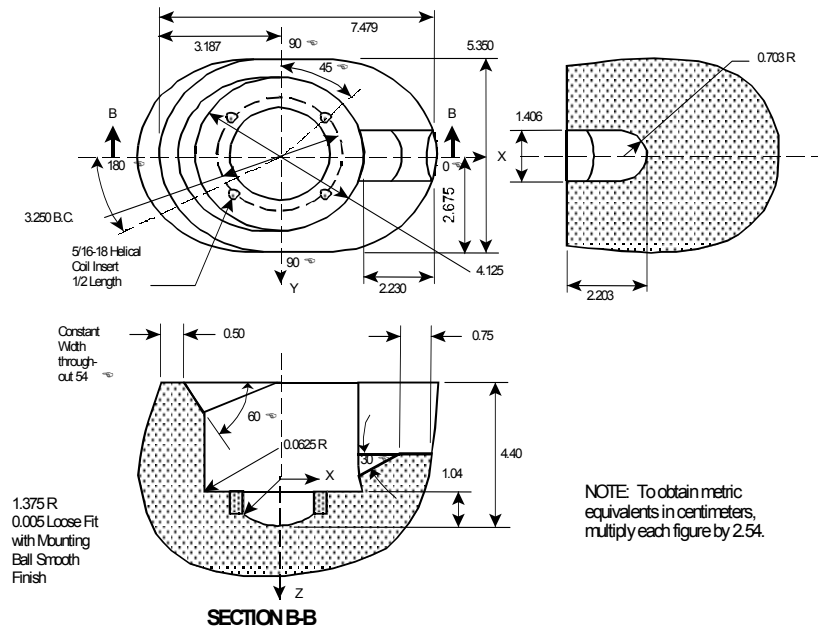
MEDIUM HEADFORM

FIGURE 5

12. COMPLIANCE TEST EXECUTION....Continued

LARGE HEADFORM

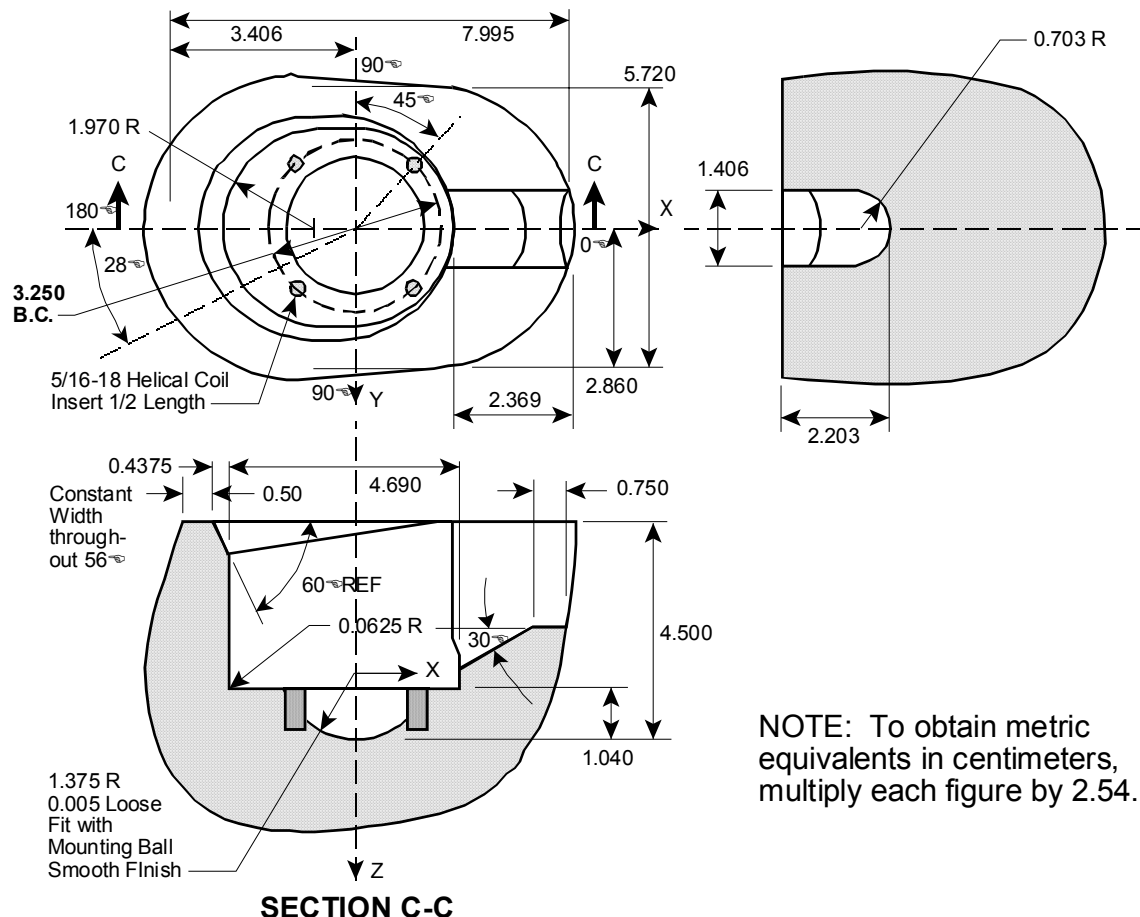


FIGURE 6

centerline of the monorail. The positive z-axis is downward. The y-axis also is horizontal and its direction can be decided by the z-axes and x-axes, using the right hand rule.

- (2) Place the subject helmet on the test headform and adjust it in accordance with the manufacturer's positioning index. Use the chin strap to fasten the helmet to the drop assembly and prevent slippage during free fall.

The laboratory shall perform impact attenuation tests within ± 45 degrees of the locations identified on Data Sheet 4, or as directed by the COTR. The impact sites may be at any point in the area above the test line and separated by a distance not less than one-sixth of the maximum circumference of the helmet in the test area.

CAUTION: Secure the helmet so that it does not shift position before impact or before application of force during testing. Do not tighten chin strap with more force that is necessary to prevent the helmet from moving before impact or before application of force during testing, as this will result in abnormal deformation and stress prior to impact.

12. COMPLIANCE TEST EXECUTION....Continued

Reposition helmet as necessary after each impact.

- (3) Raise drop assembly to the proper height using a suitable measuring technique (calibrated measuring rods are suggested).
- (4) Immediately prior to the drop, a highly accurate ($\pm 0.1\%$ voltage) calibration signal shall be injected into the system. The output produced by this signal shall be used for analysis of the acceleration-time history (trace) resulting from the helmet impact.
- (5) Simultaneously release the drop assembly and trigger the instrumentation system to permanently record the acceleration-time trace.
- (6) Repeat the above steps (changing headform position and anvils as necessary) until all 32 impacts are completed.
- (7) Perform post test systems checks in accordance with Paragraph 12.C.
- (8) Perform data reduction as follows:
 - (A) Use calibrated time base incorporated in recording device to determine dwell time at 150g and 200g.
 - (B) Determine peak acceleration using calibration signal as proportionality constant (g/in).

Accelerations in excess of 400g or dwell time in excess of 2.0 msec above 200g or 4.0 msec, above 150g shall be considered failures.

PENETRATION RESISTANCE

Test Equipment and Tolerances

- (A) Headform — Headforms used for the penetration test shall be constructed of a metal or metallic alloy having a Brinell hardness number no greater than 55. They shall be geometrically identical to the impact test headforms. If, during the course of testing, the headform is damaged (indented) by the penetration striker, it shall be repaired prior to the next test.
- (B) Striker — The weight of the penetration striker is 3kg, + 0.00kg, - 0.029kg (6.625 lbs, + 0.000 lbs, - 0.065 lbs)

The striker tip shall have an included angle of 60° , + 1.0° , - 0.0° and a cone height of 3.8cm, +0.25cm, -0.0cm (1.5 inches, + 0.1 inches, - 0.0 inches).

The striking point shall have a radius of 0.5mm radius, +0.08mm, -0.0mm (0.19 inches, + 0.003 inches, - 0.000 inches) and a minimum hardness of 60 Rockwell (Scale C).

12. COMPLIANCE TEST EXECUTION....Continued

- (C) Drop Height — Free Fall Guide — The penetration striker shall be dropped in a guided free fall from a height of 3m, + 0.0m, - 0.03m (118.1 inches, +0.0 inches, 1.2 inches), measured from the tip of the striker to the outer surface of the subject helmet when properly positioned on the test headform. The free fall guide apparatus shall be vertical within 1° and, if of a type which completely encloses the striker (such as a tube), shall provide a clearance between the striker and guide of not greater than 5.1mm (0.2 inch), total.

The laboratory must be capable of setting the drop height so that when the accuracy of the measuring device is considered in evaluating the recorded height the results are within the specified limit.

- (D) Test Location - The laboratory shall perform penetration tests at the same locations on each helmet within a model. These locations shall be above the test line such that penetration sites are at least 7.6 cm (3 inches) apart, and at least 7.6 cm (3 inches) from the centers of any impacts applied during impact attenuation testing. In addition, the location of the first penetration test shall either be randomly selected by the test lab such that it is within three inches of any point on along the mid-sagittal plane of the helmet or as directed by the COTR. The location of the second penetration test shall be randomly selected in the side area of the helmet, and outside the selection area of the first penetration test or as directed by the COTR. With a digital image, the laboratory shall document the penetration test sites for each model in the respective report.

Penetration Test Procedure

The test shall be conducted in accordance with the FMVSS 218, paragraph S7.2.

Contact between the headform and striker may be demonstrated:

- (A) electrically, by a continuity circuit with a minimum 1 msec response time, between striker and head form, or
- (B) physically, by the presence of an indentation in the test headform.

NOTE: Regardless of the test method, evidence of the penetration failure must be provided. If the test method is electrical, the test report must include a printout of the electrical signal that indicates the penetration failure. If the test method is physical, the test report must include a digital image of the witness tape or similar material that was applied to the headform before the test in order to reveal any indentation of the striker onto the headform that is indicative of the penetration failure. Further, any witness tape or similar material that shows evidence of contact must be carefully removed from the headform and retained and stored securely with the respective helmet. Removal and storage of the witness tape shall be done in such a manner as to not destroy, distort or otherwise obliterate the resultant indentation.

Regardless of method, the headform shall be inspected for damage after each penetration drop.

12. COMPLIANCE TEST EXECUTION....Continued

RETENTION SYSTEM TEST

A. Test Equipment

The test shall be conducted by placing the subject helmet on a rigidly fixed headform and fastening the chin strap around a moveable device representing the lower jaw. This device shall consist of two freely moving rollers, each having a 1.3cm, ± 0.01 cm (0.5 inch ± 0.004 inch) diameter and separated by a distance of 7.6cm ± 0.1 cm (3 inches ± 0.04 inch) measured center to center. The test load will be applied through this device as shown in Figure 7.

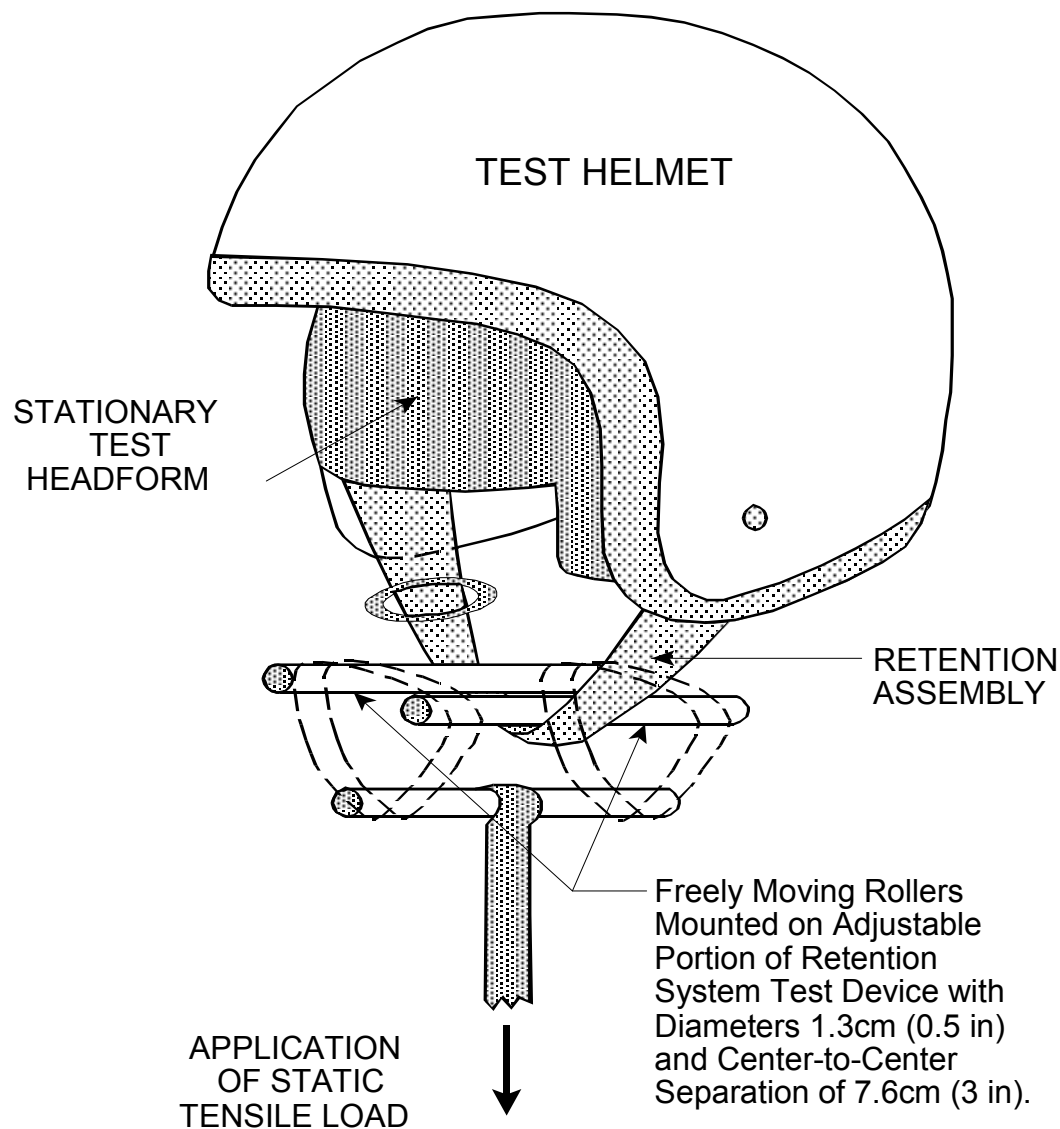
B. Test Procedure

A 22.7kg, + 4.5kg, - 0kg (50 pound, + 10 pounds, - 0 pounds) preliminary load shall be applied to the retention system and held for a minimum of 30 seconds. At this time, the vertical distance between the apex of the helmet and a fixed point on the moveable test device shall be recorded. The load shall then be increased to 131.5kg, +0.0kg, -2.3kg (290 pounds, + 0.0 pounds, - 5.0 pounds). After a minimum of 60 seconds at full test load 131.5kg, +0.0kg, -2.3kg (290 pounds, + 0.0 pounds, - 5.0 pounds), a final measurement of the vertical distance between the apex of the helmet and a fixed point on the moveable test device (same point as used for previous measurement) shall be recorded. The test load shall be maintained for 120 seconds, + 0 seconds, - 10 seconds.

The rate of application of force shall be between 1.0 and 3.0 cm per minute (0.4 and 1.2 inches per minute).

The laboratory shall be capable of applying the retention system loads so that when the accuracies of the instrumentation and the systems are considered in evaluating the recorded data the results are within the upper and lower limits of the specified conditions.

12. COMPLIANCE TEST EXECUTION....Continued

RETENTION SYSTEM TEST DEVICE**FIGURE 7**

When tested as previously described —

- A. The retention system, its components and attachments (including the helmet shell) shall attain the specified loads without separation.
- B. The adjustable portion of the retention system test device shall not move more than 2.5cm (1 inch) net, measured between preliminary and full test load positions.
- C. The contractor shall include in the report a Time vs Load plot for each of the four retention tests.

13. POST TEST REQUIREMENTS

The contractor shall re-verify all instrumentation and check data sheets and photographs. Make sure data is recorded in all data block on every compliance test data sheet.